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RESEARCH ARTICLE

Lean supply chain performance measurements in the manufacturing industry

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ABSTRACT

Purpose: The core aim of this study was to comprehend understand lean supply chain performance measurements in the manufacturing industry. ***Design/methodology/approach:*** This was a quantitative descriptive design involving Zambia's Manufacturing industry in this study. A homogenous survey form was employed. The study used a quantitative study, with a sample size of 100 workers, and 81 workers who responded favorably to the self-administrative survey. ***Conclusion:*** Customer delivery lead time matter the most for gauging the effectiveness of a lean supply chain. Supplier delivery lead time came second on the hierarchy of lean supply chain performance metrics with an average value of 4.77 and a standard deviation of 0.902. Attending to customer complaints by an organization is very important where lean supply chain performance is concerned. That being stated, Customer complaints accounted 4.51 average with standards deviation of 1.029 as a lean supply chain performance metrics. The percentage of standardized processes, Cost of energy, Total inventory and On-time delivery by suppliers all accounted for 4.28, 4.09, 4.46 and 3.97 mean values as lean supply chain performance metrics. The study further found that there are four categories of lean supply chain performance measures. These are Quality accounting for 30%, Cost accounted for 30%, Delivery and Reliability (D&R) which represented 25% and flexibility which accounted for 15% of the total four categories

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INTRODUCTION

Supply chain administrators and experts have been pushed to reevaluate their performance as a result of the rise of global marketplaces and the intense competition that followed. On the other hand, because of their outstanding accomplishments like reduced cost, higher quality, high flexibility, and JIT delivery, lean ideas and related tools, techniques, and practices are fast entering the many segments of the supply chain (Womack and Jones, 2016). Lean supply chain (LSC), a development that significantly boosts performance, is the result of combining supply chain management (SCM) with lean ideas. The effectiveness of an LSC depends on ongoing performance monitoring, measurement, and improvement since these activities help identify areas for improvement, establish goals, and choose the appropriate courses of action. The majority of businesses have learned that in order to become an efficient. It results from the reality that things that cannot be measured cannot be managed (Christopher,2021).Lean manufacturing for example is an integrated strategy to manufacturing and service organizations that aims to achieve superior quality, on-time delivery, and competitive costs to preserve customer satisfaction. Lean was first created in Japan in the 1950s and was inspired by the Toyota manufacturing system (TPS). Lean manufacturing aims to eliminate waste in labor, time to market, production space, and inventory, which increases consumer demand while producing the best goods at the lowest possible cost.

The primary component of lean manufacturing is the elimination of waste and the adoption of new work processes, while the secondary component is the market reaction). As a result, the finance matrix for supply chain performance measurement is evaluated in this study. In this investigation, the following research inquiries are discussed:

- Which metrics matter most for gauging the effectiveness of a lean supply chain?
- What are the categories of lean supply chain performance measures?

LITERATURE REVIEW

Lean supply chain (LSC), a development that significantly boosts performance, is the result of combining supply chain management (SCM) with lean ideas. The effectiveness of an LSC depends on ongoing performance monitoring, measurement, and improvement since these activities help identify areas for improvement, establish goals, and choose the appropriate courses of action. The majority of businesses have learned that they must be evaluated for their performance if they are to develop into an effective and efficient supply chain. It results from the reality that things that cannot be measured cannot be managed (Christopher, 2021). Finding and utilizing the appropriate metrics and measures is difficult in this regard.

Lean Supply Chain: Lean manufacturing is aunified strategy to manufacturing and service organizations that aims to achieve superior quality, on-time delivery, and competitive costs to preserve customer satisfaction. Lean was first created in Japan in the 1950s and was inspired by the Toyota manufacturing system (TPS). Bodoganz (2022) states that Lean manufacturing aims to eliminate waste in labor, time to market, production space, and inventory, which increases consumer demand while producing the best goods at the lowest possible cost. The first component of lean manufacturing is the elimination of waste and the application of innovative techniques to the work process. The second component is the market reaction. There is a comprehensive discussion of the emphasis on lean manufacturing plants and their evolution. To eliminate all inefficiency, including time waste, and to maintain a specific level of production, lean involves developing a value stream. Lean methodologies include JIT, TQM, equipment monitoring, TPM, Kaizen, design for production and assembly, supplier management, human resource involvement and training, decision-support systems, and variability reduction. Lean operations are characterized by reliability, dependability, and product efficiency with reduced lead times (Bodoganz, 2022). Overproduction, defects, superfluous inventory, extreme conveyance, pointless schedules, and minimum usage of people (expert training required for staff) are seven categories of process waste that are recognized with appropriate justifications. In the early 1980s, industrial industries were where the SCM idea first appeared (Womack and Jones, 2016). It grew out of breakthroughs like JIT and TQM. As defined by the Council of Supply Chain Management, SCM is the synchronization and partnership with channel partners, suppliers, and intermediaries. It also involves the preparation and administration of all operations tangled in terms of obtaining, transformation, and other transport administration operations inside a manufacturing cycle, the supply chain system connects material suppliers, production sites, and distribution channels. The supply line may be broken down into three segments, including manufacturing, sourcing, and distribution. SCM is a cutting-edge, interdisciplinary business management approach and research environment that boosts productivity and profits for businesses while fostering long-term competitiveness.

Organizations may now compete more effectively thanks to the concepts, resources, and lean approaches. The advantages of this program encouraged management to spread lean ideas across the SC and involve suppliers, distributors, manufacturers, consumers, and other stakeholders (Gomes and Mentzer, 2020). Managers should implement a variety of lean methodologies across the SC to boost overall performance. The first model concentrates on the activities that transfer raw materials and components through the manufacturing process and then to the ultimate consumer in an economically and without substantial problems. This is a key distinction between a typical model of SC and LSC. The LSC approach, on the other hand, places a strong emphasis on gaining value and removing waste that develops along the chain. There are three methods for gauging the effectiveness of lean operations, according to the literature. The first one is focused on gauging the extent of application of lean tools and processes, such as determining the level of leanness of a company. The second has to do with measuring the outcomes of a lean deployment. Cost, quality, delivery, flexibility, and ongoing development were important factors to consider in this situation. The third strategy combines the first two strategies.

Lean Supply Chain performance: Total internal lean optimization is what is meant by lean performance. Applying lean to the supply chain as a system is necessary to create a lean supply chain (Gomes and Mentzer, 2020). A lean method helps the consumer draw value from the producer by identifying the value that is inherent in certain items, identifying the value stream for each product, supporting the flow of value, and pursuing perfection. This comprehensive, corporate-wide approach to implementing lean is how the idea moves beyond functional strategy to a more expansive supply chain strategy used by the organization (Fassoula, 2018). Lean methodology's merits include a more direct and pragmatic focus on waste, flow, and flexibility (Industry Week, 2020).

An efficient organization streamlines the delivery of goods and services to its clients. It provides value to the client by:

- Shortening lead times
- Increasing standard
- Waste elimination
- Lowering overall expenses
- Inspiring and involving others.

SCM aims to improve performance by seamlessly integrating internal business processes and connecting them to the external operations of suppliers and chain participants. This approach necessitates strong coordination between a company's operations and those of its clients and vendors (Womack and Jones, 2016). The market's dynamics frequently make this coordination challenging as other businesses continue to seek out and form strategic relationships. In order to successfully profit from SCM from the external coordination, enterprises must have attained a reasonably high level of integration internally. This is a challenging task since it necessitates cooperation, integration, and coordination across enterprises and the whole supply chain. According to Christopher (2019), SCM has the ability to help firms realize cost and value benefits. There aren't many factual studies that look at how SCM affects profitability and return on sales as well as how well the supply chain performs. According to several academics, SCM may improve supply chain performance through lean management (Christopher, 2019; Christiansee and Kumar, 2020). Lean production, which is a collection of technologies and processes that attempts to continuously eliminate all waste in the manufacturing process, is the foundation of SCM. Reduced manufacturing costs, higher productivity, and shorter lead times for production are the main advantages (Womack and Jones, 2016). When Frederick Taylor and the pioneering industrial engineers started researching work techniques in the late 1980s, the first attempts at decreasing waste in production followed. Taylor dubbed his theories "scientific management" and established planning divisions staffed by engineers whose duties included creating scientific working methods, setting productivity goals, creating incentive structures for achieving the goals, and instructing staff on how to use the methods to achieve the goals (Taylor 1964,p. 25). Applications of lean manufacturing are best suited for sectors where reducing production cycle times to the barest minimum is a strategic objective and the primary source of competitive advantage (Monden, 2018). A number of instances, but the two that stand out the most are those of the manufacturing of electronics and cars, where a shorter production cycle determines competitive advantage, which typically includes the first competitive edge. According to Fassoula, 2018), implementing lean manufacturing across the value chain is necessary to reap its full benefits.

Lean Supply Chain and performance measures: By implementing lean principles, methodologies, tools, and practices across the supply chain, an LSC will be created, offering enormous prospects for additional advancements in both the individual components and the supply chain. The goal of an LSC is to increase productivity by integrating lean tools and practices across the whole supply chain to reduce waste and make it effective and efficient enough to meet the needs of all supply chain participants. Performance assessment is helpful in assessing existing performance to spot areas that may utilize considerable changes, ultimately leading to increased productivity and efficiency. Improvement requires measurement, and improvement only happens when performance has been measured and the necessary corrective measures have been taken. In this sense, performance measurements and metrics are essential to an organization's success because they support goal setting, performance assessment, and future planning.When evaluating supply chain performance, there are certain crucial factors to consider. For instance, Beamon (2021) listed the following qualities as being important to consider: inclusivity, universality, measurability, and consistency. Customers, internal processes, innovation, and finance are the four distinct sorts (dimensions) of performance measurements according to (Gunasekaran et al., 2019).

McKee and Ross (2019) added that while selecting performance measurements, the following seven principles should be taken into account:

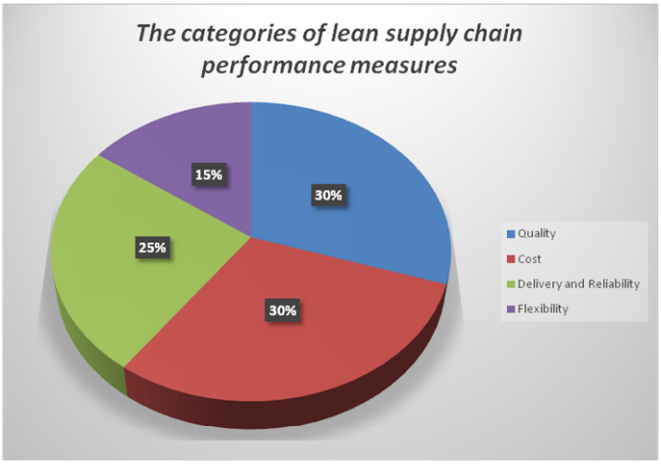
- The measures must be closely connected to the production strategy of the company.
- Non-monetary measures ought to be used.
- It should be acknowledged that different places use different measurements, and that not all departments or sites should use the same measure.
- It is important to understand that policies are subject to change as conditions develop.
- The procedures must be straightforward and user-friendly.
- The measures ought to offer quick feedback.
- Rather of only monitoring, the measurements should be created to encourage ongoing progress.

There are three methods for evaluating the effectiveness of lean. The first is gauging how well lean tools and approaches are being applied. In other words, this strategy aims to provide a response to the query, "To what extent are the lean tools and practices implemented?" (The quantity and degree of tool and method application are taken into account. For instance, Doolen and Hacker created a survey tool to gauge an organization's adoption of a wide variety of lean techniques both quantitatively and qualitatively (Haszlinna and Potter, 2018).The second approach of lean evaluation involves tracking performance results after lean deployment.

In this case, the most important factors were expense, durability, distribution and reliability (D&R), flexibility, and continuous development. The first and second strategies are combined in the third method of lean assessment. In other words, this approach will take into consideration and integrate the installation and performance of lean tools into a single index.The study conducted by Hayes, R.H., and Pisan (2017) serves as an example of this approach. After carefully examining several books and research publications on the issue, the lean features (totaling 65 approaches) and performance indicators (totaling 90 performance measures) were listed. The contrasts between Toyota and the example organization in terms of lean performance and the use of lean tools was then made (Womack and Jones, 2016).

METHODOLOGY

This study was conducted in Zambia, a nation with a low-income middle class. The research used a quantitative approach. Its objective is to test hypothesis, examine relationships and describe specific phenomena (David F. Malhotra and Naresh K. 2006). Specifically, the researcher used quantitative design to test the hypothesis and examine the influence since there was more than one variable to test.



Source: Author (2022)

Figure 1. main the categories of lean supply chain performance measures

A population can be identified as individuals, groups, events or objects which exhibit common characteristics according to Bryman and Bill (2011). For this study the research purposively selected 100 procurement professionals from the manufacturing industry. Kothari (2004) asserts that when N is big, a sample size of at least 30 is sufficient for study. 100 samples are therefore thought to be sufficient for this investigation. Statistical Package for Social Sciences (SPSS) version 20 was used to clean, organize, and evaluate the data for this research. This tool made it possible for the researcher to arrange the data and provide descriptive analysis with percentages to facilitate comprehension and conclusion-drawing. The collected data was analyzed by use of both descriptive and inferential statistics.

FINDINGS AND DISCUSSION

What are the metrics matter the most for gauging the effectiveness of a lean supply chain?: The following were found to be the main metrics matter the most for gauging the effectiveness of a lean supply chain. According to the results presented in table 1, Customer delivery lead time matter the most for gauging the effectiveness of a lean supply chain. This is shown by mean value 4.84 and standard deviation of 0.740. Supplier delivery lead time come second on the hierarchy of lean supply chain performance metrics with an average value of 4.77 and a standard deviation of 0.902. Attending to customer complaints by an organization is very important where lean supply chain performance is concerned. That being stated, Customer complaints accounted 4.51 overage with standards deviation of 1.029 as a lean supply chain performance metrics. The Percentage of standardized processes, Cost of energy, Total inventory and On-time delivery by suppliers all accounted for 4.28, 4.09, 4.46 and 3.97 mean values as lean supply chain performance metrics. The skewness and kurtosis ranged from 0.690 to 1.442 and 1.421 to 0.558 respectively.
The results in figure 3.1 show that there are four categories of lean supply chain performance measures. Quality accounted for 30%. The procedures used by businesses to evaluate, keep track of, and proactively manage the quality of the goods and procedures in the supply chain are known as "quality in supply chain." It is used to increase on-time delivery, shorten cycle and lead times, and provide a more reliable supply chain. In order to prevent severe issues like supply chain interruptions, medicine shortages, and lost income, effective supply chain quality management assists firms in identifying and fixing issues with goods or operational procedures. Equally, Cost accounted for 30% as one of the categories of lean supply chain performance measures. Supply chain cost management approaches continue to be short-term and functionally focused, according to Gartner research analysts (Hoppes, 2019). A strategic, programmatic cost optimization strategy rather than supply chain cost reducing helps to prevent hazards to supply chain cost efficiency. Urgent budget pressure is genuine. It's crucial to match company value with effective supply chain operational results to reduce supply chain expenses. Another category is Delivery and Reliability (D&R) which represented 25% of the four categories. Lin and Hui (2020) asserts that Delivery and reliability (D&R) refers to the proportion of client deliveries that are deemed error-free on the part of the vendor or shipper, as compared to the total number of deliveries that occur during a certain period of time. The goal is to calculate the proportion of successful deliveries to those that fell short of the requirements specified by the business operation. A corporation can discover delivery process defects and make modifications that assist to reduce the amount of errors that happen throughout the delivery process by conducting periodic reviews to assess the current ratio of delivery dependability. Last of the lean supply chain performance measures category is flexibility which accounted for 15% of the total four categories discussed so far. Supply chain flexibility, or the potential to swiftly adjust production levels, raw material procurement, and transportation capacity, provides various benefits over traditional supply chain management. Supply chain management practices that are still used today are rigid and do not allow for fast changes when they are needed. It is well recognized that changes in demand or delays in the supply chain can result in disruptions along the whole supply chain. The versatility of the supply chain enables it to manage the daily cyclical fluctuations.

Table 1. The metrics matter the most for gauging the effectiveness of a lean supply chain

Metrics	Mean	Std. Deviation	Skewness	Kurtosis
Percentage of standardized processes	4.28	0.781	0.690	1.320
Customer complaints	4.51	1.029	1.442	1.360
Cost of energy	4.09	1.314	1.196	1.421
Total inventory	4.46	0.851	1.363	0.995
On-time delivery by suppliers	3.97	0.720	1.108	0.870
Customer delivery lead time	4.84	1.085	0.740	1.493
Supplier delivery lead time	4.77	0.902	0.825	0.558

CONCLUSION

Customer delivery lead time matter the most for gauging the effectiveness of a lean supply chain. Supplier delivery lead time came second on the hierarchy of lean supply chain performance metrics with an average value of 4.77 and a standard deviation of 0.902. Attending to customer complaints by an organization is very important where lean supply chain performance is concerned. That being stated, Customer complaints accounted 4.51 average with standards deviation of 1.029 as a lean supply chain performance metrics. The percentage of standardized processes, Cost of energy, Total inventory and On-time delivery by suppliers all accounted for 4.28, 4.09, 4.46 and 3.97 mean values as lean supply chain performance metrics. The study further found that there are four categories of lean supply chain performance measures. These are Quality accounting for 30%, Cost accounted for 30%, Delivery and Reliability (D&R) which represented 25% and flexibility which accounted for 15% of the total four categories.

RECOMMENDATIONS

Since all expenses ultimately end up being passed on to customers, most cutting-edge businesses have discovered that shifting costs either upstream or downstream actually has little impact on their ability to compete. In order to boost total channel sales and profitability, rather than fighting for a larger portion of a set profit, supply chain management advises businesses to work together. The idea of lean management is one method for coordinating inside and across businesses with an emphasis on efficiency, avoiding waste or overburden, and adding value to products. Zambian manufacturing enterprises must consistently enhance their performance in both products and processes to fulfill the rising demand for high-quality goods by sophisticated domestic and international customers. Lean manufacturing techniques provide everyone in a business a shared vision on how to enhance quality. This goal is not just driven by the market but also necessary for survival during a period of unpredictable economic conditions.

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